RE-ENTERABLE HOUSING FOR xDSL/POTS SPLITTER

FIELD OF THE INVENTION

[1] The present invention relates generally to telecommunications networks, and more particularly, to a housing for an xDSL/POTS splitter that permits a digital subscriber line (DSL) to be interconnected with customer premises equipment at a location remote from the telephone company central office.

BACKGROUND OF THE INVENTION

[2] It is anticipated that optical networks will someday extend higher bandwidth service, and in particular higher bandwidth access to the Internet, all the way from the telephone company central office to the home. At present, however, such all-optical networks are not generally available, especially in the segment of the network known as the "last mile." Accordingly, telecommunications service providers are currently developing digital subscriber line (DSL) networks to meet the demand for higher-bandwidth access to the Internet over existing copper telephone lines. Several DSL technologies are presently available or in development, including for example, HDSL, IDSL, SDSL, VDSL, RADSL, and ADSL. The various DSL technologies are collectively referred to herein generically as "xDSL." Asymmetric DSL (ADSL) is particularly suited for access to the Internet because the majority of transmissions travel downstream to Internet users and upstream bandwidth can be reduced in favor of increased downstream bandwidth. With upstream bandwidth reduced, ADSL can provide downstream bandwidth up to about 8 Mbps. Another advantage of xDSL technologies is that many, including ADSL, can simultaneously carry lower frequency voice signals and higher frequency data signals over the same telephone line. The voice signals, referred to herein as Plain Old Telephone Service (POTS) signals, are typically transmitted over a frequency band from about 100 Hz to about 4 kHz. As a result, conventional customer premises equipment, such as standard telephones, answering machines, facsimile machines and analog modems, can be used to transmit and receive POTS signals over an ADSL line.

ADSL data signals, on the other hand, are typically transmitted upstream over a frequency band from about 85 kHz to about 95 kHz, and are typically received downstream over a frequency band from about 100 MHz to about 500 MHz. As a result, higher frequency customer premises equipment, such as computers and digital modems, are required to transmit and receive data signals over an ADSL line.

[3] Because xDSL technologies utilize lower frequency bands for POTS signals and higher frequency bands for data signals, splitters must be employed at some point in the telephone line between the telephone company central office and the customer premises. In the past, a first analog or digital splitter has been utilized at the central office to combine the POTS signal and the data signal into a combined signal over an ADSL line. A second analog or digital splitter is provided at the customer premises to separate the combined signal into the POTS signal for conventional customer premises equipment and the data signal for higher frequency customer premises equipment. Typically, the lower frequency POTS signal is filtered from the combined signal at both the first and the second splitter using a low-pass filter. The higher frequency data signal may also be filtered from the combined signal at one or both of the first and second splitters using a high-pass filter. The filtered voice signal and/or the filtered data signal may then be passed upstream of the first (i.e., central office) splitter through an analog to digital converter. The filtered and converted voice signal is preferably transmitted by a conventional telephone switch over a digital pulse code modulated (PCM) highway in a known manner. Similarly, the filtered and converted data signal is preferably transmitted over a high speed, high bandwidth, digital data highway, for example a T1 line, in a known manner.

[4] The most significant disadvantage of xDSL technologies, and in particular ADSL technology, is that transmission over existing copper telephone lines is limited in range to about 18,000 feet from the telephone company central office due to line losses. Thus, a significant number of the homes and businesses demanding ADSL service are not within the desired range of the telephone company central office for optimal performance. Most, if not all, telecommunications networks, however, already utilize termination equipment to interconnect conventional customer premises equipment with a POTS line at a location

remote from the telephone company central office. The POTS line termination equipment is typically housed in a telecommunications enclosure, such as an above-ground pedestal or an aerial, pole-mounted or buried closure. The POTS line termination equipment includes connectors, for example conventional screw terminals or insulation displacement contact (IDC) terminals, that interconnect a copper wire pair from the customer premises equipment with a copper wire pair from the telephone company main distribution cable. It would be advantageous to likewise interconnect higher frequency customer premises equipment with an ADSL line at a location remote from the telephone company central office, thereby providing DSL service, such as higher speed Internet access, to customers that are located more than about 18,000 feet from a telephone company central office. The present invention addresses this need by providing a housing for an xDSL/POTS splitter that permits a digital subscriber line (DSL) to be interconnected with customer premises equipment at a location remote from the telephone company central office.

BRIEF DESCRIPTION OF THE DRAWINGS

[5] The present invention will be described in conjunction with the accompanying drawings in which like reference numerals represent the same or similar parts in the various views. The drawings, which are incorporated in and constitute a part of this specification, provide further understanding of the invention, illustrate various embodiments of the invention, and, together with the description, fully explain the principles and objectives thereof. More specifically:

FIG. 1 is a perspective view of a re-enterable housing according to the invention affixed to a telecommunications enclosure at a location remote from a telephone company central office;

FIG. 2 is a detail perspective view of the re-enterable housing of FIG. 1 shown with the cover in the opened position;

FIG. 3 is a detail plan view of the re-enterable housing of FIG. 2; and

FIG. 4 is a schematic diagram illustrating the direction of transmission of the POTS signal, the data signal and the combined signal between the re-enterable housing of FIG. 1 and the telecommunications enclosure.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[6] The present invention is described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. The invention may, however, be embodied in many different forms, and therefore, should not be construed as being limited to the embodiments described and shown herein. Illustrative embodiments are set forth herein so that this description will be thorough and complete, and will fully convey the intended scope of the invention, while enabling those skilled in the art to make and practice the invention without undue experimentation.

[7] Referring now to FIG. 1, a telecommunications enclosure, and in particular an above-ground pedestal **10**, houses termination equipment for interconnecting conventional customer premises equipment, such as a standard telephone, facsimile machine or analog modem, with a Plain Old Telephone Service (POTS) line from the telephone company central office. The POTS line comprises a main POTS distribution cable **16** that is buried underground and enters the pedestal **10** from underneath the cabinet **12**. In the particular embodiment shown and described herein, the pedestal **10** further houses termination equipment for interconnecting higher frequency customer premises equipment, such as a computer or digital modem, with a data line from the telephone company central office or another source, for example an Internet Service Provider (ISP). The data line comprises a main data distribution cable **17** that likewise is buried underground and enters the pedestal **10** from underneath the cabinet **12**. The POTS distribution cable **16** and the data distribution cable **17** each comprise a plurality of copper wire pairs, referred to in the art as "twisted pairs." At least some of the wire pairs of the POTS distribution cable **16** and the data distribution cable **17** are interconnected with wire pairs from the customer premises equipment that are routed to the pedestal **10** through one or more drop cables **18**. The remainder of the wire pairs of the POTS distribution cable **16** and the data distribution cable **17** may be routed out of the pedestal **10** along the POTS line and the data line to yet another pedestal in the telecommunications network located remote from the telephone company central office. The pedestal **10** provides a convenient access point in the telecommunications network for a field technician from the telephone company to initially

install and subsequently reconfigure the connections between the drop cables **18** and the POTS distribution cable **16** and the data distribution cable **17**. The particular pedestal **10** shown in FIG. 1 provides POTS and higher frequency data service to customers of the telephone company, such as homes and businesses, that are located more than about 18,000 feet from the central office. Although an above-ground pedestal is shown and described, the telecommunications enclosure may also be an aerial, pole-mounted or buried closure, or any other enclosure in a telecommunications network at a location remote from a telephone company central office.

[8] A housing **20**, constructed in accordance with the invention is also shown in FIG. 1. The housing **20** is operatively coupled to the telecommunications enclosure as will be described hereinafter. As shown in FIGS. 2 and 3, housing **20** comprises a base **22** and a cover **24** each made of a lightweight, yet rigid material, such as aluminum, plastic or thermoplastic. The cover **24** is movably attached to the base **22** such that the cover may be opened and closed on the base. Accordingly, the housing is re-enterable for a purpose to be described. As shown, the base **22** is affixed to the exterior surface of one of the side walls **13** of the cabinet **12**. The base **22**, however, may be affixed at any convenient location on the exterior of the cabinet **12**, or may be affixed at any convenient location on the interior of the cabinet **12**. If located on the interior of the cabinet **12**, the housing **20** is accessed through doors **14**, which are typically secured by a lock mechanism that can only be opened by authorized personnel, such as a field technician, dispatched from the telephone company. Furthermore, the cover **24** may be affixed to the cabinet **12** instead of the base **22** and the base may be adapted to be opened and closed on the cover. Regardless, the base **22** and the cover **24** are positioned relative to the pedestal **10** such that the housing **20** is operatively coupled to the telecommunications enclosure located remote from the telephone company central office. As such, the housing **20** may be provided with brackets or straps (not shown) for securing the base **22** (or cover **24**) to the pedestal **10**, a telephone pole, building or other structure, or may be provided with hangars for suspending the housing **20** from an aerial cable strand in a known manner. Although the housing **20** depicted in the exemplary embodiment is shown as an in-line type housing, it may be configured in any known manner, such as a canister or "butt" type housing, without departing from the intended spirit or scope of the invention.

[9] As shown herein, the base **22** is generally box-shaped and defines an interior cavity **21** for housing telecommunications hardware, such as routing, signal processing and terminating equipment. The base **22** may have any of a variety of shapes, such as square, circular, oval or elliptical, that is suitable for housing telecommunications hardware and for interconnecting wire pairs from one or more drop cables **18** with wire pairs from the POTS distribution cable **16** and the data distribution cable **17**. As shown and described herein, the base **22** is generally rectangular in the lengthwise and widthwise dimensions and is elongated in the lengthwise dimension (relative to the widthwise dimension) between a pair of opposed, closed ends **23**. Preferably, the depth dimension is substantially less than either the lengthwise dimension or the widthwise dimension to optimize access to the routing, signal processing and terminating equipment at any location within the interior cavity **21** of the base **22**. As previously mentioned, the cover **24** is attached to the base **22** and adapted to be opened and closed thereon. As shown, the cover **24** is generally rectangular and is hingedly affixed to the base **22** along an upper edge of one of the side walls by a continuous hinge **25**. Preferably, the hinge **25** is a mechanical hinge. However, the hinge **25** may also be formed as a living hinge when the base **22** and the cover **24** are integrally molded from a plastic material. In another embodiment, the cover **24** may be slidably attached to the base **22** to expose selected portions of the interior cavity **21** of the base **22**. Alternatively, the entire cover **24**, or only a portion of the cover **24**, may be removably attached to the base **22** to provide unobstructed access to the interior cavity **21**. The base **22** or the cover **24** is preferably provided with clasps (not shown) or other conventional means for securing the cover **24** to the base **22** in the closed configuration. The base **22** or the cover **24** may also be provided with conventional means for retaining the cover **24** in the opened configuration. If necessary, the cover **24** may be provided with lengthwise or widthwise stiffening ribs **26** to strengthen and prevent distortion of the cover **24**.

[10] The housing **20** is shown in FIGS. 2 and 3 with the cover **24** hingedly affixed to the base **22** and opened thereon. At least one, and preferably a plurality, of wire port assemblies **30** are provided on the opposed end walls **23** of the base **22**. In the embodiment illustrated in FIG. 1, the housing **20** is mounted in any suitable manner on a telecommunications enclosure

(e.g., above ground pedestal **10**) at a location remote from the telephone company central office. An opening is formed through a side wall **13** of the cabinet **12** of the pedestal **10** for receiving a conduit **19**. Conduit **19** is routed from the interior of the pedestal **10** through the opening in the side wall **13** to one of the wire port assemblies **30** in an end wall **23** of the housing **20**. The conduit **19** provides a "wire-way" for gathering and routing wire pairs from the interior of the telecommunications enclosure (e.g., pedestal **10**) to the interior cavity **21** defined by the base **22**. Typically, a portion of the sheath of the POTS distribution cable **16** and the data distribution cable **17** is removed so that the wire pairs are exposed within the interior of the pedestal **10**. At least one of the wire pairs of the POTS distribution cable **16** and at least one of the wire pairs of the data distribution cable **17** are gathered and routed through the conduit **19** into the interior cavity **21** defined by the base **22** for a purpose to be described hereinafter. The remainder of the wire pairs of the POTS distribution cable **16** and the wire pairs of the data distribution cable **17** are interconnected with wire pairs of one or more drop cables **18**, or continue uninterrupted through the interior of the pedestal **10** and back into the distribution cables **16**, **17** to provide telecommunications service at another location in the network remote from the telephone company central office. The latter instance described above will be readily recognized by those skilled in the art as a "taut sheath" application.

[11] In the embodiment illustrated, the conduit **19** is routed through the wire port assembly **30** formed in the lower end wall **23** of the base **22**. The wire port assembly **30** located in the end wall **23** typically receives only one conduit **19**, but may receive two conduits **19**; one containing wire pairs of the POTS distribution cable **16** and one containing wire pairs of the data distribution cable **17**. A third conduit **19** may also be received by a wire port assembly **30** in either end wall **23** of base **22** to gather and route wire pairs that carry a combined signal comprising the POTS signal and the data signal, as will be described hereinafter. As shown herein, one of the ports **31** of the wire port assembly **30** in end wall **23** is not utilized and a single conduit **19** containing one or more wire pairs of the POTS distribution cable **16**, the data distribution cable **17** and the combined POTS and data signal is received within the other port. However, multiple conduits **19** may be received within one or more ports of either wire port assembly **30** to gather and route the wire pairs into the housing **20** as required for a

particular application. Furthermore, one or more additional conduits **19** may be positioned within an unused port **31** of either wire port assembly **30** at a later time to expand the service capacity of the housing **20**. Each wire port assembly **30** has at least one, and preferably a plurality of semi-circular recesses formed in base **22** and a corresponding plurality of semi-circular recesses formed in cap **32**. Cap **32** is shown in FIG. 2, but is shown removed in FIG. 3 for purposes of clarity. One or more conduits **19** are received within the semi-circular recesses formed in the base **22**. The cap **32** engages the base **22** such that the semi-circular recesses of the cap **32** are aligned with the semi-circular recesses of the base **22** and each conduit **19** is retained in a sealed manner between the base **22** and the cap **32**. As shown, each wire port assembly **30** has two semi-circular recesses formed in base **22** and cap **32** that permit additional conduits **19** to be installed into the housing **20** without disturbing any conduit **19** previously installed. If less than four conduits **19** are disposed between the base **22** and the cap **33**, any empty recesses may be fitted with a sealing plug (not shown) so that the housing **20** is thereby sealed and remains substantially rainproof.

[12] The interior cavity **21** defined by the base **22** of the housing **20** contains passive electronics for combining the POTS signal on the POTS line with the data signal on the data line, and for separating the POTS signal or the data signal from the combined signal onto the POTS line or the data line, respectively. The POTS signal and the data signal are combined and separated so that customers of the telecommunications network located more than 18,000 feet from the telephone company central office can transmit and receive higher frequency communications, for example high speed Internet access, over a single telephone line, for example a digital subscriber line (DSL). Combining and separating the signals at a telecommunications enclosure, such as pedestal **10**, located remote from the telephone company central office reduces the inherent losses in the combined signal transmitted and received over the DSL. The passive electronics do not require external power. As a result, the POTS signal remains available for emergency voice communications on the DSL in the event of an electrical power outage between the customer premises and the telephone company central office. In the embodiment shown and described herein, the passive electronics comprise at least one xDSL/POTS splitter **40** positioned within the interior cavity

21 defined by the base **22**. The passive electronics may further comprise a back-plane circuit board **44** and at least one wire connector **46**, as will be described hereinafter.

[13] As illustrated schematically in FIG. 4, the xDSL/POTS splitter **40** combines a POTS signal **50** on the POTS line and a data signal **60** on the data line into a combined signal **70** on a DSL for communications between the telephone company central office and the customer premises equipment. Similarly, the xDSL/POTS splitter **40** separates the combined signal **70** on the DSL into a POTS signal **50** on the POTS line and a data signal **60** on the data line for communications from the customer premises equipment to the telephone company central office. The xDSL/POTS splitter **40** may be any suitable means for combining and separating the POTS and data signals. For purposes of example only and not by way of limitation, the xDSL/POTS splitter **40** may be an electrical circuit comprising a low-pass filter for separating the POTS signal **50** from the combined signal **70** for communications from the customer premises equipment to the central office. Obviously, the low-pass filter will also pass the POTS signal **50** to be combined with the data signal **60** into the combined signal **70** for communications from the central office to the customer premises equipment. Alternatively, the xDSL/POTS splitter **40** may comprise a high-pass filter for separating the data signal **60** from the combined signal **70** for communications in the direction of the central office. Obviously, the high-pass filter will also pass the data signal **60** to be combined with the POTS signal **50** into the combined signal **70** for communications in the direction of the customer premises equipment. Of course, the xDSL/POTS splitter **40** may comprise both a low-pass filter and a high-pass filter that separate the POTS signal **50** and the data signal **60** from the combined signal **70** and combine the POTS signal **50** and the data signal **60** into the combined signal **70**, in a manner well known and understood in the art.

[14] The xDSL/POTS splitter **40** may be mounted on a conventional circuit card **41** having a board edge connector (not shown) and the passive electronics may further comprise a back-plane circuit board **44** disposed within the interior cavity **21** defined by the base **22**. The back-plane circuit board **44** has at least one card socket connector **45** (FIG. 3) for receiving the board edge connector of the circuit card **41** so that the xDSL/POTS splitter **40** is in electrical communication with the back-plane circuit board **44**. As shown, the back-plane

circuit board **44** has 10 socket connectors **45**, 3 of which have circuit cards **41** (each having an xDSL splitter **40**) installed therein. Typically, each circuit card provides DSL service to a separate drop cable **18**. Thus, the remaining socket connectors **45** are available for future expansion of the housing **20** to service additional drop cables **18**. As previously mentioned, the POTS signal **50** is carried by a plurality of wire pairs of the POTS distribution cable **16** and the data signal **60** is carried by a plurality of wire pairs of the data distribution cable **17**. Similarly, the combined signal **70** is carried by a plurality of wire pairs of the one or more drop cables **18** routed between the xDSL/POTS splitter **40** and the customer premises equipment. The wire pairs for the POTS signal **50**, the wire pairs for the data signal **60** and the wire pairs for the combined signal **70** may be terminated directly on the circuit card **41**, for example by soldering to wire terminations. The POTS signal **50** and the data signal **60** are then combined or the combined signal **70** is then separated by the xDSL/POTS splitter **40** as previously described. Alternatively, the passive electronics may further comprise at least one wire connector **46** disposed within the interior cavity **21** defined by the base **22** for interconnecting the wire pairs for the POTS signal **50** and the wire pairs for the data signal **60** with the wire pairs for the combined signal **70**. The wire connector **46** comprises a plurality of terminals, for example screw terminals or insulation displacement contact (IDC) terminals, that electrically connect the wire pairs to a socket connector **45** on the back-plane circuit board **44**. For example, the screw terminals or IDC terminals may be electrically connected to the socket connector **45** through circuit lands provided on the back-plane circuit board **44** to route the signals **50, 60, 70** between the wire connector **46** and the xDSL/POTS splitter **40** on the circuit card **41** received within the socket connector **45**. Accordingly, the xDSL/POTS splitter **40** becomes active when the circuit card **41** is installed into the socket connector **45** and the appropriate wire pairs are connected to the corresponding terminals on the wire connector **46**. As a result, the combined signal **70** is carried on the DSL comprising drop cable **18** between the telephone company central office and the customer premises equipment. The combined signal **70** is separated again into the POTS signal **50** and the data signal **60** at the customer premises in a known manner as required for use with conventional customer premises equipment and higher frequency customer premises equipment. The configuration and operation of the splitter at the customer premises is well known and understood by those skilled in the art, and thus, forms no part of the present invention.

[15] The illustrative embodiments of a re-enterable housing for an xDSL/POS splitter operatively coupled with a telecommunications enclosure at a location remote from a telephone company central office as shown and described herein provides a number of significant advantages. In particular, a housing according to the invention permits a digital subscriber line (DSL) to be interconnected with customer premises equipment at a location remote from the telephone company central office. Accordingly, DSL service, such as higher speed Internet access, may be provided to customers that are located more than about 18,000 feet from a telephone company central office. The housing may be affixed to the exterior of the telecommunications enclosure or, if space permits, may be affixed to the interior of the telecommunications enclosure. The housing permits a sufficient number of xDSL/POTS splitters to be installed to meet the initial demand for DSL service, yet the housing is re-enterable to also permit a filed technician to subsequently reconfigure the housing with additional xDSL/POTS splitters and thereby expand service to additional customer premises. The wire pairs of the POTS line, the data line and the DSL may be terminated directly to the xDSL/POTS splitter, or may be terminated to at least one wire connector that is electrically connected to the xDSL/POTS splitter through a back-plane circuit board. The wire connector may comprise conventional screw terminals or IDC terminals.

[16] Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed herein and that further modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.